The Use of Honey in White and Whole Wheat Bread[1]

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HONEY has been used by man for thousands of years and remains the only natural ready-to-eat sweet in existence. As early as 3,000 B.C., beekeeping was standard practice along the Nile River. It is mentioned in the Bible many times, and has always been highly esteemed for its sweetness and flavor. Honey comes to us unequaled as a natural source of sweetening power. It is only natural to assume that the use of honey in food manufacture would be desirable.

Except during times of sugar shortages, the baking industry has used honey in limited quantities. Honey, being a natural product, tends to be variable in chemical composition as well as flavor, aroma, and color. This variation is largely due to differences in floral sources, areas of production, and weather conditions. The importance of these variables as they are related to bread production and quality have not been studied previously. Under present streamlined bakery production systems, variability of any formula ingredient is not conducive to uniformly high quality in baked products. Therefore, if the natural variables present in honey, such as moisture content, acidity, levulose-dextrose ratio, ash and dextrin can be compensated for, so as to produce products of uniform quality, it is conceivable that the baking industry would utilize honey in greater quantities.

The use of certain honeys, because of excessively strong flavor or dark color, may be limited to given types of bakery products. Such honeys have long been a drug on the honey market, and if it is possible to ascertain specific uses for these honeys, the honey producers will realize a gain. The literature gives little information on the relation of floral source to suitability for specific types of baked goods.

Handling problems are also associated with the use of honey by the baker, particularly if large quantities are involved. Honey is at present shipped and stored in five gallon (60-pound) cans. Additional labor (an expensive item) is required in order to remove all the honey from these cans and thus eliminate loss due to waste. Often honey is received in granulated condition, necessitating the use of special knowledge and equipment before this honey can be removed from the cans. If it is desirable to ship honey in granulated form, perhaps more suitable containers could be provided. Honey in dehydrated form would seemingly solve many of these problems, but it is not known whether this would be economically feasible. Sugar sirups are transported in tanks and metered to the mixer in some bakeries. Perhaps a similar method for handling honey in large quantities could be worked out.

It has been the object of the present research to study the use of various flavors and composition as they affect production and quality of white and whole wheat breads. It has also been the object to gather information which will permit the establishment of grades of honey best suited to production of specific products.

Selection and Treatment of Honeys

Fifteen honeys, chosen for their variation in chemical composition, color, and flavor, were selected for this study. All honeys were ordered in the raw state, in order that each could be given identical treatment to prevent granulation. The treatment was accomplished by immersing the honeys in a water bath at 160°F., filtration through six layers of cheesecloth, and rapid cooling. Chemical analyses of the honeys as well as grade, floral source, and area of production are shown in Tables I and II.

METHODS

All experiments were conducted on a pilot plant scale. Sucrose was used in the control formula in all baking tests. On a basis of equal sugar content, various honeys were substituted for sucrose and conclusions derived are based on comparison of the resulting products. Baking tests were repeated several times in order to obtain the most accurate data possible. Physical dough properties were also closely observed.

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Since it was desired to learn the effects of variable moisture content among the honeys, absorption was adjusted to include the moisture present in the added honeys on an average basis of 17.5% moisture content. This allowed 7.3% honey to equal 6% sucrose in sugar solids. Likewise, a reduction of approximately 1% in dough absorption was found to account for this additional moisture.

Since various sugar concentrations are used commercially, baking tests were conducted at 3% and 6% sugar levels based on flour as 100% in the formula. Six per cent sugar is probably somewhat above the normal amount used in commercial practice. All doughs were given identical treatment in mixing, fermentation, proofing and baking.

Alpha-amylase activity of the honeys as determined by the modified Wohlgemuth method (Cereal Chem. 16:712-723, 1939) was essentially immeasurable. This shows that honey would not contribute any diastatic effects to the breadmaking process. It should be noted that honey which has not been heat-treated to 160°F. may contribute diastatic effects to the breadmaking process.

Proteolytic activity of the various honeys was also determined, using the modified Ayre-Anderson method (J.A.O.A. C., Nov. 1947). Horsemint honey was highest in proteolytic activity, assaying 0.125 unit per 0.4 gram of honey solids. Proteolytic activity contributed by honey would therefore be negligible in bread, even when amounts higher than 6% honey were used.

Effect of Honeys on White Bread Quality

Close observation of dough handling properties did not reveal any differences in mixing, fermentation, machining, proofing or baking qualities of the doughs containing honey or sucrose, at either the 3% or 6% sugar level.

Except for a very slight effect on crumb color when buckwheat and fall flowers honeys were used at the 3% level, all other characteristics of the honey breads were indistinguishable from those made with sucrose. Small differences were noted regarding grain and texture at the 6% level. Buckwheat and fall flowers honeys produced bread with texture judged to be harsh. The use of honey at the 6% level produced prominent effects on crumb color. Differences seemed to be directly proportional to the color of the honey used. Only buckwheat, fall flowers, and Spanish needle produced undesirable effects. All the bread received maximum score on other characteristics.

Effect of Honey on Crumb Moisture Retention and Crumb Firmness

Samples of bread crumb were air-dried 24 hours, after which they were subjected to oven-drying at 130°C. for one hour in order to determine whether honey produced any effects on moisture retention in the bread. No significant differences were noted between either the sucrose or honey breads at either the 3% or 6% honey level. Any hygroscopic properties of the honey are apparently lost because most of the sugar is fermented out during the bread making process.

The Bloom gelometer was employed for tests on crumb compressibility to determine if honey would produce softer bread. No significant differences were detected at either sugar level between those loaves made with honey or sucrose.

Consumer Acceptability of Bread Made with Honey

The effects of various honeys on aroma and taste of bread are very important. Organoleptic tests were performed at both 3% and 6% honey levels in order to determine whether or not the presence of the honey in bread could be detected by the consumer, and to determine which flavors, if any, might not meet with consumer acceptance.

At the 3% honey level, 55% of the tasting panel detected the presence of honey in the bread. When honey was increased to 6%, detection by the panel increased to 59%. Statistical analysis showed those percentages to be highly significant.

Further organoleptic testing to determine which of the honeys might lend an offensive aroma or flavor to the bread showed a total of 21% of unfavorable reactions. Of these, 62.5% were divided between buckwheat, heartsease, fall flowers and tupelo honeys. Buckwheat and heartsease honeys were shown to be definitely undesirable, while tupelo and fall flowers were borderline cases. Orange is a strong-flavored honey which proved to be quite acceptable.

Another series of organoleptic tests showed that buckwheat honey could be used when mixed with a mild-flavored clover honey in amounts up to 10% of the blend. Tupelo, heartsease, and fall flowers could be blended with a mild flavored clover honey in amounts up to 15% and still meet with consumer approval. Use of these honeys did not show deleterious effects on bread quality at the 6% level. It was assumed that other honeys could be blended in any proportion, since they were acceptable when used alone.

Toasting of Bread Containing Honey

A portion of nearly every loaf of commercial white bread is consumed as toast. Therefore, the effects of toasting honey bread are quite important. The aroma of honey in the bread is amplified by the

Table I. Source, grade, color, and partial chemical analysis of honeys.

Floral source	Area source	Water %	Color† mm	Grade name§	Grade	Ash %	Units pH
Y. sweet clover	Kansas	17.1	25	white	A	0.07	3.9
Mesquite	Texas	17.2	32	white	A	.09	4.0
Ariz. alfalfa	Arizona	15.1	44	ext. lt. amber	A	.29	4.0
Star thistle	California	16.4	49	ext. lt. amber	A	.13	3.7
Tupelo	Florida	18.8	54	ext. lt. amber	C‡	.10	3.9
Eucalyptus	California	17.7	64	lt. amber	A	.24	4.0
White clover	California	15.9	22	white	A	.07	3.8
Orange	California	16.4	21	white	A	.07	3.7
Heartsease	Iowa	17.0	50	ext. lt. amber	A	.07	4.0
Horsemint	Texas	19.8	40	ext. lt. amber	C‡	.21	3.6
Spanish needle	Kansas	18.1	73	lt. amber	A	.20	4.4
Buckwheat	New York	19.7	119	dark	C‡	.09	3.9
Fall flowers	New York	17.8	111	amber	A	.17	4.0
Lt. amb. alfalfa	California	15.4	53	lt. amber	A	.16	3.9
Cotton	Texas	16.4	26	white	A	.18	3.9

† Color in millimeters Pfund.
‡ Exceed maximum moisture limits for grade "A."
§ Ext. lt. — extra light.

heat in the toasting process, resulting in an exceptionally good effect for several honeys. Buckwheat, horsemint, and heartsease honeys produced objectionable odors. Cotton, orange, white clover, star thistle and sweet clover honeys were judged best. Others were regarded as giving off a fairly good aroma. There was no difference in appearance or palatability between those slices containing honey or sucrose.

Conclusions Regarding the Use of Honey in White Bread

The use of honey to replace 6% sucrose in white bread presents no problems in production. No changes are required in absorption, mixing, fermentation machining, proofing or baking time. Natural variation in the levulose-dextrose ratio, pH, nitrogen, sucrose, moisture and dextrin content of the various honeys cannot be detected in the baked bread. The most distinguishing effects of honey on white bread production are on aroma, flavor and color. The effect of honey on crumb color of bread is proportional to the pfund value. Buckwheat, fall flowers, horsemint and heartsease honeys were the only honeys that were considered undesirable. These honeys may be blended with other desirable honeys to the extent of 10% of the blend. Orange and tupelo honeys retain strongly their distinct honey flavors after baking of the bread.

Whole Wheat Bread

Results of the experiments performed on white bread with respect to moisture retention, crumb firmness and variables of chemical nature are also applicable to whole wheat bread. However, due to the flavor and crumb color masking qualities of whole wheat bread, it was thought that greater quantities of honey could be utilized in this type of product. Experiments were performed with the intention of determining maximum limits of honey that could be used without deleterious effect on production or quality. Whole wheat bread was made containing 3, 6, 9, and 12% of honey solids.

Heartsease and buckwheat honeys produced a musty aroma and taste in whole wheat bread. At levels of 6% and more, horsemint and fall flowers honeys were undesirable. Tupelo and orange honeys were easily detected in the bread at all levels. Other honeys were not detectable as such, but did enhance the flavor of the bread considerably.

When honey was increased beyond 6%, deterioration of bread quality was observed. Problems in fermentation and machining also occurred at the 9 and 12% levels. It is very evident that the old adage about too much of a good thing also applies to honey used in bread.

Conclusions Concerning Whole Wheat Bread

Floral sources of buckwheat, heartsease, fall flowers, and horsemint honeys are not recommended for use in whole wheat breads except in blended form as previously described for white bread. Since horsemint honey is the milder of these honeys, it is assumed a blend containing 15% horsemint would be as acceptable as fall flowers honey in a similar blend. The use of any honey in amounts greater than 6% results in lowering bread quality and necessitates special handling. Richness of flavor is enhanced by the use of honey, but if honey flavor is especially desired, tupelo or orange honeys give best results.

Consumer acceptance tests were not carried out on whole wheat bread, but in the opinion of the scorers, tupelo honey would be as acceptable as orange honey in whole wheat bread.

Proposed Specifications for Purchase of Honey for Use in White or Whole Wheat Bread

1. All honey containers should be clearly labeled, showing grade, floral source, moisture content and color in mm Pfund as well as U. S. Department of Agriculture color standards.
2. Honey for bakers' use should be "U. S. Grade A" or "B," according to U. S. standards for grades of extracted honey, effective April 16, 1951.
3. The Pfund colorimeter reading should not exceed 70 mm for honey to be used in white bread.
4. Predominant floral sources of buckwheat, fall flowers, heartsease, and tupelo honeys should not be used in white bread, except in blends as noted in item 6.
5. Buckwheat, fall flowers, heartsease, and horsemint honeys should not be used in whole wheat bread, except in blends as noted in item 6.
6. Blends of acceptable honeys containing 10% of buckwheat, or 15% of heartsease, fall flowers, or tupelo honeys are acceptable.
7. Honey should conform to Pure Food and Drug Laws for this commodity.
8. Honey for bread baking purposes should be heat-treated at 160°F. for 30 minutes to retard granulation and enzyme activity.

Table II. Sugar analysis of honeys.

Floral Source	Sucrose %	Levulose %	Dextrose %	Levulose / Dextrose	Dextrin %
Y. sweet clover	6.5	41.2	33.8	1.22	0.15
Mesquite	2.0	42.0	35.0	1.20	.20
Ariz. alfalfa	3.2	39.6	38.5	1.03	.57
Star thistle	2.3	38.9	36.6	1.06	.64
Tupelo	2.1	42.8	30.8	1.39	.25
Eucalyptus	2.2	39.8	33.8	1.17	.43
White clover	3.9	40.2	37.8	1.06	.12
Orange	7.2	40.6	35.0	1.16	.19
Heartsease	3.3	40.7	37.4	1.09	.03
Horsemint	3.7	38.7	35.7	1.08	.32
Spanish needle	3.6	43.1	31.3	1.38	1.93
Buckwheat	3.3	37.8	35.4	1.06	.54
Fall flowers	2.9	38.6	37.9	1.02	.50
Lt. amb. alfalfa	4.7	41.6	35.1	1.19	.12
Cotton	3.2	39.5	38.6	1.02	.39

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